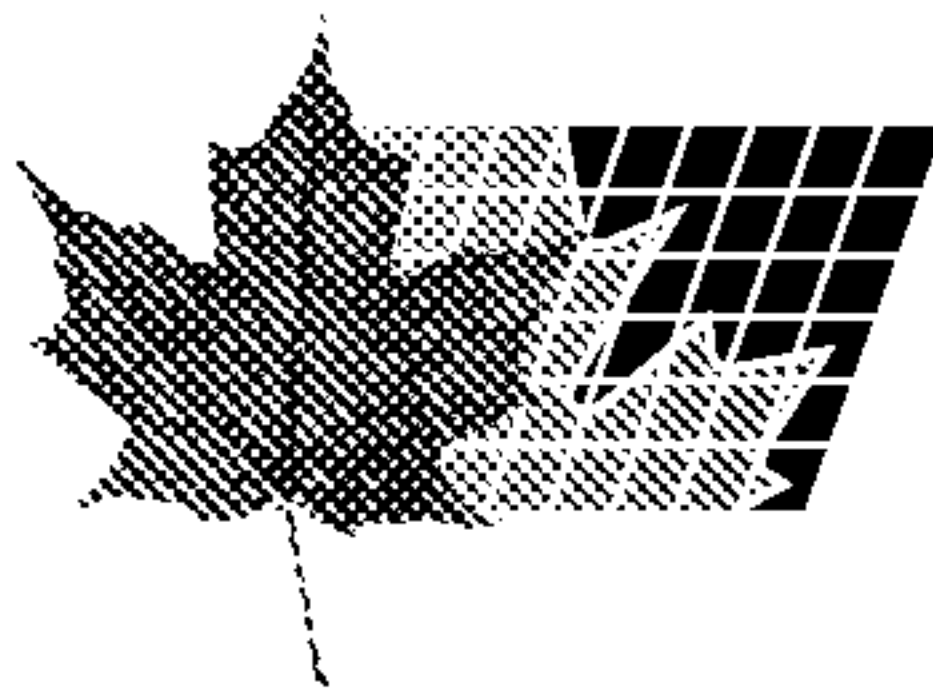




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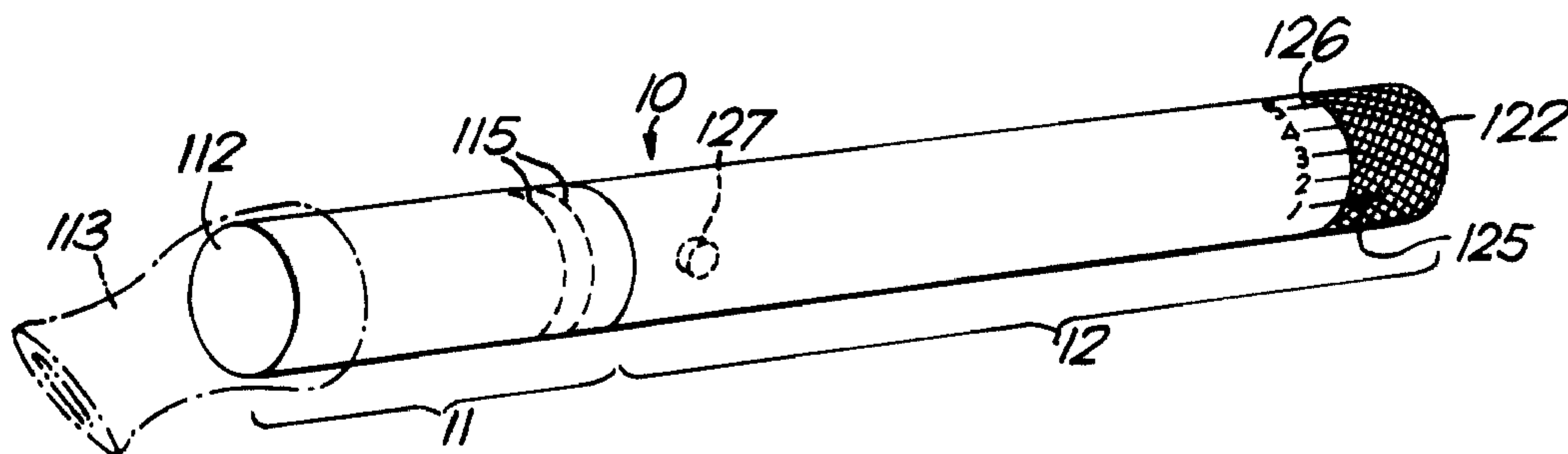
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(54) **ARTICLE AROMATISEUR**

(54) **FLAVOR GENERATING ARTICLE**



(57) An article is provided in which a flavor generating medium is electrically heated to combustion to evolve inhalable flavors or other components in vapor and/or aerosol form. The article has a plurality of charges of the flavor generating medium which are heated to combustion sequentially to provide individual puffs.

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FLAVOR GENERATING ARTICLE

Abstract of the Disclosure

An article is provided in which a flavor
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FLAVOR GENERATING ARTICLE

Background of the Invention

This invention relates to articles in which discrete charges of a flavor generating media are
5 burned to release tobacco flavors. More particularly, this invention relates to electrically heated articles.

It is known to provide smoking articles in which a flavor bed of tobacco or tobacco-derived material is heated, without combustion of tobacco, to
10 release tobacco flavors without producing all the normal products of tobacco combustion. For example, it is known to provide a smoking article having a bed of tobacco-derived material and a combustible heat source. A smoker draws air through or around the heat source,
15 heating it, and the heated air passes through the flavor bed, releasing tobacco flavors that are drawn into the smoker's mouth. The heat source temperature is dependent on how the smoker uses the article, so that the flavor release rate varies widely from user to
20 user, and from article to article for a particular user.

Articles that produce the taste and sensation of smoking by heating tobacco electrically are also known. However, in some known electrically heated
25 articles the temperature was not consistent because the output of the electrical power source was not well regulated, so that the release of flavors also was not consistent. In other known electrically heated articles the power source was external to the article
30 and inconvenient.

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U.S. Patent 5,095,921, issued March 17, 1992 and assigned to Philip Morris Incorporated, teaches heating, but not burning, discrete charges of a flavor generating media to produce an aerosol. Heating discrete charges eliminates sidestream smoke. Heating, but not burning, the flavor generating media eliminates many of the normal products of combustion. However, the control circuitry required to heat flavor generating media without burning it often is complicated.

10 It would be desirable to be able to provide an electrically heated article which produces a predetermined release of flavor with each puff.

It would also be desirable to be able to provide such an article which consistently for each puff reaches its operating temperature quickly and remains at that temperature long enough to cause burning of its flavor source, while at the same time minimizing the consumption of energy.

20 It would further be desirable to be able to provide such an article which is self-contained.

It would still further be desirable to be able to provide such an article which can have the appearance of a conventional cigarette, but does not produce sidestream smoke, and is not hot between puffs.

25 Summary of the Invention

It is an object of this invention to provide an electrically heated article which produces a consistent release of flavor with each puff.

30 It is also an object of this invention to provide such an article which consistently for each puff reaches its operating temperature quickly and remains at that temperature long enough to cause burning of its flavor source, while at the same time minimizing the consumption of energy.

35 It is a further object of this invention to provide such an article which is self-contained.

It is still a further object of this invention to provide such an article which can have the appearance of a conventional cigarette, but does not produce sidestream smoke, and is not hot between puffs.

5 In accordance with this invention, there is provided an article for delivering to a consumer a flavor-containing substance. The article comprises a plurality of charges of flavor generating medium, electrical heating means for individually heating to
10 combustion each of the plurality of charges, a source of electrical energy for powering the electrical heating means, and control means for applying the electrical energy to the electrical heating means to individually heat one of the plurality of charges.
15 Each of the charges, when heated to combustion, delivers a quantity of flavor-containing substance to the consumer.

Brief Description of the Drawings

The above and other objects and advantages of
20 the invention will be apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

25 FIG. 1 is a perspective view of a first embodiment of an article according to the present invention;

FIG. 2 is a partially fragmentary exploded perspective view of the article of FIG. 1;

30 FIG. 3 is a perspective view of a more preferred second embodiment of an article according to the present invention;

FIG. 4 is an exploded perspective view of the article of FIG. 3;

35 FIG. 5 is a perspective view of a still more preferred article according to the present invention;

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FIG. 6 is an exploded perspective view of the article of FIG. 5;

FIGS. 7A-7K are perspective views of various embodiments of heaters for use in the present invention;

FIGS. 8A-8C are views of a particularly preferred embodiment of heaters for use in the present invention;

FIG. 9 is a schematic diagram of a preferred power source for use in the present invention; and

FIG. 10 is a schematic diagram of a preferred embodiment of a control circuit for use in the present invention.

Detailed Description of the Invention

15 The basic article of the present invention includes a source of electrical energy, an electrical heater or heaters, electrical or electronic controls for delivering electrical energy from the source of electrical energy to the heaters in a controlled
20 manner, and a flavor generating medium in contact with, or acted on by, the heater. When the heater heats the flavor generating medium to cause combustion, flavor-containing substance -- i.e., a vapor or aerosol, or mixture thereof, containing flavored vapors or aerosols
25 or other vapor or aerosol components -- is generated or released and can be drawn in by the consumer. (In the discussion that follows, either of the words "generate" or "release", when used alone, includes the other, and the word "form", when used in connection with the
30 phrase "flavor-containing substance," means "generate or release.")

The flavor generating medium can be any material that, when heated to combustion, releases a flavor-containing substance. Such materials can
35 include tobacco, tobacco condensates or fractions thereof (condensed components of the smoke produced by the combustion of tobacco, leaving flavors and,

possibly, nicotine), or tobacco extracts or fractions thereof, deposited on an inert substrate. These materials when combusted generate or release a flavor-containing substance (which may include nicotine) which can be drawn in by the consumer. Any of these flavor generating media can also include an aerosol-forming material, such as glycerine or water, so that the consumer has the perception of inhaling and exhaling "smoke" as in a conventional cigarette. A particularly preferred material is a composition such as that described in copending, commonly-assigned United States patent application Serial No. 222,831, filed July 22, 1988, hereby incorporated by reference in its entirety, which describes pelletized tobacco containing glycerine (as an aerosol-forming ingredient) and calcium carbonate (as a filler). As used in the present invention, the composition, instead of being formed into pellets, would be deposited as a coating, in conjunction with adhesion agents such as citrus pectin, on a heater or on an inert substrate in contact with a heater.

The flavor generating medium is divided into individual charges, each representing one puff of the article. It is possible to mimic a conventional cigarette by providing a number of charges of flavor generating medium equal to an average number of puffs per cigarette, e.g., eight to ten puffs. Although the article does not decrease in length like a conventional cigarette as it is operated, it is possible to make the article in varying lengths, with different numbers of puffs. By providing individual charges for each puff, one reduces the total amount of flavor generating medium that must be provided, as compared with a single larger charge that would be electrically heated or reheated once for each of several puffs.

The portion of the article according to the present invention that contains the heaters and the flavor generating medium is preferably a replaceable

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plug-in unit, so that when all of the charges have been heated to combustion, the spent plug-in unit can be discarded and a new one inserted. The controls and power source could be retained.

- 5 One embodiment of article 10 according to the invention is shown in FIGS. 1 and 2. Article 10 is the simplest form of article according to the present invention, and includes heater/flavor/mouthpiece section 11 and power and control section 12.
- 10 Section 11 includes a plurality of heaters 110, each having deposited on its surface a quantity of flavor generating medium 111. The heater configuration shown in FIG. 2 is illustrative only. Different possible heater configurations will be discussed below.
- 15 Preferably, there is a segment of filter material 112, such as conventional cellulose acetate or polypropylene cigarette filter material, possibly in conjunction with paper-wrapped tobacco rod sections, at the mouth end of section 11, both for aesthetic purposes as well as to
- 20 provide appropriate filtration efficiency and resistance-to-draw to the system. In addition, mouthpiece 113 can optionally be included.

As shown in FIG. 2, there are ten heaters 110 in section 11. There are also eleven contact pins 114

25 extending from section 11 remote from its mouth end -- one common pin and ten pins connected to individual heaters 110 -- that fit into eleven sockets 120 on section 12 to make electrical contact between heaters 110 and power source 121, the nature of which

30 will be discussed in more detail below.

A knurled knob 122 is provided at the remote end of section 12 to allow the consumer to select one of the heaters 110. Knob 122 controls a single-pole ten position rotary switch 123, connected by wires 124

35 to sockets 120. Index mark 125 on knob 122 and graduations 126 on the body of section 12 assist the consumer in selecting the next heater 110. To operate article 10, the consumer selects a heater 110 using

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knob 122 and presses momentary-on pushbutton switch 127 to complete the circuit and energize the selected heater 110 to initiate heating. Flavor generating medium 111, thus heated to combustion, can release or
5 generate a flavor-containing substance. The consumer draws in the flavor-containing substance along with air drawn through perforations 115 in the outer wrapper of section 11 or 12; which could be conventional cigarette paper or tipping paper. Air may also enter through the
10 end of section 12 remote from the mouth end through channels that may be provided for that purpose, carrying the air around power source 121 and around other internal components of section 12. What is important is that the air enter section 11 at a point
15 at which it can fully sweep heaters 110 to carry the maximum amount of flavor-containing substance to the mouth of the consumer.

When all ten charges in section 11 have been heated to combustion, section 11 is spent, and can be
20 unplugged from article 10 and a new section 11 can be plugged in. Section 12 as envisioned is reusable.

In article 10, it is possible that the consumer will select a particular heater 110 more than once, giving rise to the possibility of reselecting a
25 previously-combusted flavor generating medium, unless knob 122 is designed so that it can only be rotated in one direction and only for one complete revolution. But in that case, its ability to rotate would have to be restored when section 11 is replaced, which is
30 mechanically complex to achieve. Therefore, a more preferred embodiment 30 of an article according to the present invention, shown in FIGS. 3 and 4, includes controls that automatically select which charge will be heated to combustion. Because the flavor generating
35 medium will be combusted, complex controls for controlling the duration of heating are unnecessary.

Article 30 includes a heater/flavor/mouthpiece section 11 identical to section 11 of

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article 10. However, power and control section 31 contains electronic control circuit 32 (described in more detail below) in place of mechanical switch 123 of power and control section 12 of article 10. Control
5 circuit 32, in response to depression of pushbutton 127, selects one of charges 111 that has not previously been used, and supplies power from power source 121 to the associated heater 110. Control circuit 32 may also
10 limit the operation of the heater to a predetermined duration. After all ten charges 111 have been used, circuit 32 no longer supplies power to any heater until spent section 11 is replaced by a fresh unit. Optionally, control circuit 32 also locks out
15 pushbutton 127 for a predetermined lockout period after each depression, so that heaters 110 are not energized too soon one after the other. Because heaters 110 are preferably part of replaceable heater/flavor/mouthpiece section 11, they need not be capable of more than one use.

20 Articles according to the present invention do not decrease in length like conventional cigarettes do as they are smoked, because only the flavor generating medium burns. Therefore, in order to provide some indication to a consumer of how much of
25 article 30 has been used or remains to be used, visual indicators 33, which can be a series of ten light emitting diodes or a bar graph or similar indicator, under the control of circuit 32, are preferably provided to display either how many of charges 111 have
30 been used or how many remain. Similarly, there is no glowing coal as in a conventional cigarette to indicate to the consumer that the article is operating. Optionally, an additional light emitting diode 34 or similar indicator, also under the control of
35 circuit 32, can be provided to show when one of heaters 110 is energized. An additional indicator or indicators (not shown) may also be provided to show

that the lockout period is in effect or that it is **2035761**
over.

In the most particularly preferred embodiment, an article according to this invention does not have a pushbutton 127, but is responsive to the consumer's drawing on the article, similarly to a conventional cigarette. Therefore, article 50, shown in FIGS. 5 and 6, is identical to article 30, except that section 52 lacks pushbutton 127. Pushbutton 127 is replaced by a switch 53 in section 52 that is sensitive either to pressure changes or air flow changes as the consumer draws on article 50. It has been found that when a Model 163PC01D36 silicon sensor, manufactured by the MicroSwitch division of Honeywell, Inc., Freeport, Illinois, is used in a preferred embodiment of the invention, the appropriate heater is activated sufficiently rapidly by the change in pressure when the consumer draws on article 50. In addition, flow sensing devices, such as those using hot-wire anemometry principles, have been successfully demonstrated to actuate the appropriate heater sufficiently rapidly after sensing a change in air flow.

A heater used in smoking articles constructed in accordance with this invention may be designed to have a "hot spot" which has a higher electrical resistance than other portions of the heater. Hot spots heat faster than other areas of the heater, causing the flavor generating medium adjacent to the hot spot to initiate combustion. Relatively little energy must be applied to the heater to initiate combustion. After the flavor generating medium adjacent the hot spot begins combustion, combustion propagates through the surrounding flavor generating medium. Combustion propagation may be assisted by including an oxidizing agent in or adjacent to the flavor generating medium (as discussed below). Designing hot spots into heaters reduces the amount of

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energy required to reach the combustion temperature, and provides a means for modifying the burn characteristics of a given heater/flavor generating medium combination.

5 In a preferred embodiment of the invention, oxidizing agents are added to either the flavor generating medium, the heater, or a composite heater/flavor generating medium. An oxidizing agent may also be placed adjacent to the heater and flavor
10 generating medium. The oxidizing agent promotes combustion. It reduces the energy (and temperature) required to attain combustion of the flavor generating medium. Oxidizing agents suitable for use in this invention must be non-toxic when combusted.

15 The linear array of heaters 110 shown in FIGS. 2, 4 and 6 is shown for ease of illustration only, and does not necessarily represent the preferred embodiment of heaters to be used in the present invention. Possible heaters for use in the present
20 invention are described in copending, commonly-assigned United States patent application Serial No. 07/444,569, filed December 1, 1989, and hereby incorporated by reference in its entirety. A number of different possible additional heater configurations are shown in
25 FIGS. 7A-7K. The different configurations reflect both mechanical considerations -- e.g., ease of manufacture -- and materials considerations -- e.g., the effect of the heater material on the composition of the flavor-containing substance.

30 For example, linear heaters 110 shown in FIGS. 2, 4 and 6 could be bars or mesh of stainless steel or other suitable metals or ceramics, although the flavor generating medium would adhere more readily to a mesh.

35 A preferred material for the heaters is graphite. Graphite heaters, possibly compounded with other forms of carbon to provide the desired electrical resistance and therefore the desired heating, are

stable, and can be molded, extruded or machined into many forms and attached, by suitable contacts, to power source 121. For example, a cylindrical graphite structure 70 as shown in FIG. 7A can be formed with a number of inwardly directed vanes 701 equal to the desired number of puffs. The inner surfaces 702 of structure 70 can be coated with the flavor generating medium. By connecting one pole of power source 121 to the outer surface 703 of structure 70, and sequentially connecting the other pole to the inwardmost edge 704 of each vane 701, one can heat each vane 701 to the desired temperature. Inwardmost edge 704 of each vane 701 is increased in thickness as compared to the body of vane 701 for added strength and to provide a conductive pathway to improve the uniformity of electrical flow and heating across the vane to maximize the use of available heater surface area. Covering both surfaces of each vane 701 with flavor generating medium also maximizes the use of available heater area and, thus, heater energy. Concentrating the flavor-generating medium further increases the amount of flavor-containing substance generated or released per unit of expended electrical energy.

Similarly, graphite structure 71 can be provided which functions like structure 70, except that vanes 711 radiate outwardly from a central core 713, as shown in FIG. 7B. The flavor generating medium is deposited on the surfaces 712 between vanes 711. Power can be applied between core 713 and the outer edge 714 of the appropriate vane 711. Outer edge 714 of each vane is increased in thickness as compared to the body of vane 711 for added strength and to provide a conductive pathway as discussed above.

Each of structures 70 and 71 has eight vanes 701, 711, representing eight charges of flavor generating medium which provide eight puffs. The structures shown below would provide ten puffs.

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Structure 72 shown in FIG. 7C is a hollow cylinder of graphite, divided by nine opposed pairs of slits 720, 721 into ten opposed pairs of segments 722, 723. The flavor generating medium is coated on the inner or outer surface 724 of cylinder 72. When one pole of power source 121 is connected to each of opposed segments 722, 723, heat is generated predominantly in that pair only, heating to combustion the flavor generating medium coated onto that pair. Although all ten pairs are interconnected at midline 725, at most a low current flows along midline 725 outside the pair being heated. The flavor generating medium coated on cylinder 72 may be applied in discrete increments corresponding to the number of heater segments (see, e.g., FIGS. 7G, 7I, and 7J), thus providing a "fire break" between each of the charges to prevent undesired propagation of combustion.

Structure 73 shown in FIG. 7D is a solid or hollow (not shown) cylinder of graphite, with ten grooves 730 formed in its surface, separating eleven lands 731. Grooves 730 are coated with flavor generating medium 732. By applying power source 121 across two adjacent lands 731, one heats structure 73 between those two lands 731, causing combustion of the flavor generating medium 732 in groove 730 therebetween.

Structure 74 shown in FIG. 7E is a graphite ring divided by two interleaved sets of ten slots each, one set of slots 740 extending from one side 741 of the ring, and the other set of slots 742 extending from the other side 743 of the ring, forming ten U-shaped fingers 744 that are coated inside or outside with flavor generating medium 746 adjacent side 741, and ten uncoated bases 745 adjacent side 743, each base 745 connected to one leg each of two adjacent fingers 744 so that two adjacent bases 745 contact opposite ends of one finger 744. By applying power from source 121 across two adjacent bases 745 heat is generated

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predominantly in that the finger 744 that they contact in common, heating the flavor generating medium thereon to combustion.

Structure 75 shown in FIG. 7F is similar to structure 74, except that it has only five each of slots 740 and 742, and the flavor generating medium 750 is confined to the band of overlap of slots 740 and 742, thus forming ten separate areas of tobacco-derived material 750, as well as five bases 751 and five fingers 752. Bases 751 and fingers 752 are arranged so that when one pole of power source 121 is applied to one base 751, two areas 750 can be heated sequentially by sequentially applying the other pole of power source 121 to each of two adjacent fingers 752. To heat further areas 750, the second pole of power source 121 is left attached to the second one of fingers 752 and the first (or third) pole of power source 121 is connected to a different base 751, and so on.

Structure 76 shown in FIG. 7G is similar to structure 72 shown in FIG. 7C, except that a slidable heater 760 is provided to serially heat each pair of opposed segments 722, 723 by conduction, convection or radiation as it is moved in the direction of arrow A. Optionally, structure 703 can be indexed through stationary heater collar 760. A variant structure 77 shown in FIG. 7H is an extruded rod 770 (hollow or solid) made solely of flavor generating medium and components to add mechanical strength, provided with slidable heater 771. Heater 771 is similar to heater 760. The heater is moved in the direction of arrow A, either manually by the consumer, or automatically by electromagnetic or mechanical means (not shown) linked to the consumer's actuation of the heater with pushbutton 127 or with a switch activated by either pressure or airflow provided by the consumer during a puff. For example, in addition to closing electrical contacts, pushbutton 127 could also engage a mechanical

ratchet (not shown). Alternatively, the closing of switch 127 (or alternative switches) could, in addition to providing current for the heaters, move a pawl which allows a spring attached to collar 760 or 771 to move
5 the collar one position in the direction of arrow A.

The same principle can be applied to each of the three heater structures shown in FIGS. 7I, 7J and 7K. Structure 78 of FIG. 7I is a thermally conductive substrate divided by slots 780, 781 into
10 strips 782, 783. Applying heat to the width-wise strips defined by opposed pairs of strips 782, 783 causes heat to flow primarily to those width-wise strips, heating that section of substrate 78 and combusting flavor generating medium 784 thereon. Heat
15 is applied to strips 782, 783 by passing substrate 78 through a heater 785. The movement of substrate 78 through heater 785 in the direction of arrow A can be accomplished in any of the ways set forth above for the movement of collars 760, 771. Heater 785 can be
20 disposable, as part of section 11, or permanent, as part of section 12, 31 or 52, with only substrate 78 being replaced as part of section 11.

Structure 79 of FIG. 7J is similar to structure 78, except that substrate 79 is made from
25 graphite, which serves as its own heater, so that heater 785 can be omitted and replaced with electrical contacts (not shown) for applying power across strips 782, 783 of substrate 79.

Structure 790 of FIG. 7K has an inert
30 substrate 791 on which lines 792 of flavor generating medium, mixed with graphite or similar material to make it conductive, are laid. Contacts similar to those used with structure 79 are used to apply power across lines 792, which, by virtue of their conductivity, form
35 their own heaters integral with the flavor generating medium.

FIGS. 8A-8C show a particularly preferred embodiment of a heater structure 80 for use with the

present invention. Structure 80 includes ten U-shaped heater elements 81 connected to a central hub 82.

Preferably, heater elements 81 are made of graphite.

Hub 82 serves as one contact point for the application of power to each heater element 81, while outer edge 83 of each heater element 81 serves as the second contact point for that respective heater. Hub 82 is connected to one contact and outer edges 83 are connected to a series of ten contacts that are activated sequentially to sequentially heat heater elements 81. (As used herein, "sequentially" does not necessarily imply any spatial order, but only that some individual element is heated after some other individual element.)

Whatever heater design is used, it is subject to several design criteria. First, the electrical resistance of the heater should be matched to the voltage of power source 121 so that the desired rate of heating is accomplished. At the same time, the resistance must be large compared to the internal resistance of power source 121 to avoid excessive losses due to the internal resistance. Second, the surface area must be sufficient to allow for support of the flavor generating medium with proper thickness of the flavor generating medium to allow rapid heating and with proper area for combustion to propagate. Third, the thermal conductivity, heat capacity and heater mass must be such that the heat generated is conducted effectively to the flavor generating medium but not away from the heater to the surroundings, and such that excessive energy is not necessary to heat the heater itself.

The contact resistance between the heater material and the contacts should be kept low. If necessary, suitable materials, such as tantalum, can be compounded or coated at the contact points to lower contact resistance. Any materials added should be non-reactive at the operating temperatures.

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Heater/flavor/mouthpiece section 11

preferably would contain heater elements as described ...
above coated with flavor generating medium, all wrapped
in a tube, which can be made of heavy paper, to allow
5 it to be inserted by a consumer into section 12, 31
or 52.

Power source 121 preferably must be able to
deliver sufficient energy to combust ten charges of
flavor generating medium, while still fitting
10 conveniently in the article. However, the energy to be
delivered is not the only criterion, because the rate
at which that energy is delivered -- i.e., the power --
is also important. For example, a conventional
AAA-sized alkaline cell contains enough energy to
15 initiate combustion of several hundred charges of
flavor generating medium, but it is not designed to
deliver the necessary energy at a high enough rate. On
the other hand, nickel-cadmium (Ni-Cad) rechargeable
batteries are capable of providing much greater power
20 on discharge. A preferred power source is four N50-
AAA CADNICA nickel-cadmium cells produced by Sanyo
Electric Company, Ltd., of Japan. These batteries
provide 1.2-volts each, for a total of 4.8 volts when
connected in series. The four batteries together
25 supply about 264 milliwatt-hours, which is sufficient
to power at least one ten puff article without
recharging. Of course, other power sources, such as
rechargeable lithium-manganese dioxide batteries, can
be used. Any of these types of batteries can be used
30 in power source 121, but rechargeable batteries are
preferred because of cost and disposal considerations
associated with disposable batteries. In addition, if
disposable batteries are used, section 12, 31 or 52
must be openable for replacement of the battery.

35 If rechargeable batteries, as preferred, are
used, a way must be provided to recharge them. A
conventional recharging unit (not shown) deriving power
from a standard 120-volt AC wall outlet, or other

sources such as an automobile electrical system or a separate portable power supply, can be used. The charge rate and controller circuitry must be tailored to the specific battery system to achieve optimal recharging. The recharging unit would typically have a socket into which the article, or at least section 12, 31 or 52, would be inserted. Contacts 128 on section 12, 31 or 52 connected to power source 121 would contact corresponding contacts in the recharging unit.

The energy content of a battery in power source 121 can be more fully exploited, despite the power or current limitation of the battery, if a capacitor is included in power source 121 as well. The discharge of the capacitor can be used to power heaters 110. Capacitors are capable of discharging more quickly than batteries, and can be charged between puffs, allowing the battery to discharge into the capacitor at a lower rate than if it were used to power heaters 110 directly.

An idealized schematic form of a power source 121 including a capacitor is shown in FIG. 9. Capacitor 90 is part of a series R-C circuit 91 with resistor 92, in which capacitor 90 is charged between puffs by battery 93 with a time constant RC , where R is the resistance of resistor 92 and C is the capacitance of capacitor 90. (In a real, non-ideal circuit, resistance R would also include the internal resistance of battery 93 and the impedance of capacitor C , as well as the resistance of any wires or other conductors in circuit 91.) In this embodiment, pushbutton (or pressure- or air flow-sensitive device) 127 acts as a single-pole, double-throw momentary switch that normally connects capacitor 90 to R-C circuit 91 for charging. When contact is made by depression of pushbutton 127 (or by activation of the above-mentioned devices), capacitor 90 can be disconnected from

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charging circuit 91 and connected to discharge across heater resistance 110.

Alternatively, power source 121 could include only capacitor 90, with no battery. In such an embodiment, contacts 128 would have to be touched to an external power source to charge capacitor 90. Capacitor 90 could be sized in such a case to require charging after each puff, or to be capable of being charged for a number of puffs (e.g., the same as the number of charges of flavor generating medium in the article). The external power source could be a specially-designed ashtray or other appliance (not shown) having power contacts for mating with contacts 128. The ashtray itself could be battery powered or could contain a power supply that connects to a 120 volt AC wall outlet. Another type of external power source could be a socket provided on an automobile dashboard and connected to the electrical system of the automobile, similar to the cigarette lighter currently provided in automobiles.

In another possible embodiment, energy would be coupled to the article by magnetic or electromagnetic induction, followed by suitable rectification and conditioning prior to charging the capacitor. For example, the specially designed ashtray referred to above could contain suitable circuitry for coupling magnetic or electromagnetic energy to the article.

If a capacitor is used in the article, the required capacitance is determined by the voltage available for charging and the maximum amount of energy to be stored. For example, if the voltage available is 6 volts and the amount of energy needed for a single puff is 10 joules, then the required capacitance is 0.56 farads. The capacitance needed would increase proportionally if energy for multiple puffs is to be stored. Preferably, the capacitor also has a very low internal resistance, so that the time constant for

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discharging into heater 110 is determined exclusively by the heater resistance and the capacitance.

The most preferred embodiment of the present invention includes control circuit 32 of FIG 10.

5 Control circuit 32 preferably fulfills several functions. It preferably sequences through the ten (or other number of) heaters 110 to select the next available heater 110 each time switch 127 is closed. It preferably applies current to the selected heater
10 for a predetermined duration that is long enough to initiate combustion of the charge of flavor generating medium. It preferably controls indicators 33, 34 which show how much of the article remains or has been used and when one of heaters 110 is active. In addition, it
15 may also lock out switch 127 for a predetermined time period after each actuation to allow time to charge capacitor 90 in power source 121, and to avoid inadvertently energizing the next heater 110.

A preferred embodiment of control circuit 32
20 is shown in FIG. 10. In FIG. 10, all points labelled V_+ are connected to the positive terminal of power source 121, and all points labelled as ground are connected to the negative terminal of power source 121.

Each heater 110 is connected to V_+ directly,
25 and to ground through a respective field-effect transistor (FET) 900. A particular FET 900 will turn on under control of standard 4028-type CMOS BCD-to-decimal decoder 901 (via pins 3, 14, 2, 15, 1, 6, 7, 4). Decoder 901 is also connected (via pin 11) to the
30 complementary output of a 4047-type CMOS timer 902 (also via pin 11). Pin 11 of decoder 901 is high when the output of timer 902 (pin 10) is low. All outputs of decoder 901 remain low if a BCD code greater than or equal to 1001 is applied to its inputs. Therefore an
35 output of decoder 901 can only be on during a positive clock pulse to 4024-type CMOS counter 903. Decoder 901 will decode a standard BCD 4-bit code input from counter 903 into 1-of-10 outputs. Decoder 901 is

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connected to supply voltage V_+ (at pin 16) and to ground (at pin 8). Decoder 901 receives BCD input from counter 903 (at pins 10, 13, 12).

Heater-active indicators 33 (light-emitting diodes (LEDs) or other indicator devices) are connected to V_+ through an ADG508-type multiplexer 904 (via pins 4, 5, 6, 7, 12, 11, 10, 9) supplied by Analog Devices of Norwood, Massachusetts. LEDs 33 are connected to ground via a 2 K Ω current-limiting resistor 905. Multiplexer 904 is connected to V_+ (via pins 2, 13, 8) and to ground (via pins 14, 3). Multiplexer 904 receives BCD input from counter 903 (via pins 1, 16, 15). The operation of multiplexer 904 is similar to that of decoder 901 in that it receives BCD input from counter 903, and decodes it such that an individual output is selected through which V_+ is supplied, but in this case to LEDs 33 rather than to heaters 110.

Counter 903 is connected to V_+ (via pin 14) and to ground (via pins 8, 7), and receives a positive clock pulse from timer 902 (via pin 1). Counter 903 is reset to 0 via a positive pulse (through pin 2). BCD output is provided at pins 12, 11, 9, 6. Every time the clock pulse (received at pin 1) changes from positive to ground, counter 903 advances one count. Counter 903 counts positive clock pulses and converts the count to BCD. The output at pin 6 is connected to pin 6 of timer 902.

Timer 902 is in a monostable configuration and is connected to V_+ (via pins 4, 8, 14) and to ground (via pins 5, 7, 12, 9) for negative triggering (through pin 6). Negative triggering is accomplished by leaving pin 6 positive and then briefly pulling it to ground to initiate the timing sequence. When triggered, the complementary outputs (via pins 10, 11) change for a time period that is dependent upon resistance value R of resistor 906, preferably 2 M Ω .

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(connected between pins 2, 3), and a capacitance value C of capacitor 907, preferably 1 μ F (connected between pins 1, 3).

5 Puff actuator 908 is the source of the negative trigger at pin 6 of timer 902. Puff actuator 908 has two power inputs (for V_+ and for ground), and one output. The output drives the gate of a MOSFET switch 909. The source of MOSFET switch 909 is connected to counter 903 (at pin 6). The drain of
10 MOSFET switch 909 is connected to timer 902 (at pin 6). Puff actuator 908 can be a device similar to silicon based pressure sensitive sensor Model 163PC01D36 referred to above, or a gas flow transducer such as a wheatstone bridge semiconductor version of a hot wire
15 anemometer.

Resistor 910 preferably has a value of 1 M Ω , while resistors 911, 912, 913 preferably all have values of 100 K Ω . Capacitors 914, 915, 916 preferably all have values of 0.1 μ F.

20 Prior to the consumer taking the initial puff, the control circuitry is turned on via on/off switch 917 or similar device. The heater active indicator LED 33 is illuminated for the first heater 110. Correspondingly, heater number 1 is selected by
25 decoder 901 and awaits firing. Counter 903 is reset to begin counting. Timer 902 complementary output at pin 10 is low (which is the clock to counter 903, pin 1) and at pin 11 is high (which keeps the heater from firing via pin 11 of decoder 901). When the
30 consumer takes a puff, puff actuator 908 causes a trigger of timer 902. The RC time constant is set by resistor 910 and capacitor 913 such that a pulse of desired duration is output from complementary outputs at pins 10, 11 of timer 902. The output from pin 11 of
35 timer 902, connected to pin 11 of decoder 901 goes low, causing the first heater to be heated. The output at pin 10 of timer 902 stays high for the duration set by RC then goes low causing counter 903 to advance one

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count. The output at pin 11 returns high,
discontinuing heater activation. Since the count of
counter 903 has advanced by one, the heater active LED
illuminated via multiplexer 904 has correspondingly
5 advanced, and the next heater to be fired in sequence
has been selected via decoder 901. This cycle will
repeat until the final heater has been heated. At such
time, pin 6 of counter 903 will go high causing
timer 902 to become non-triggerable. In such case the
10 heater firing sequence is halted until the circuit is
reset by turning it off then on again.

Although not implemented in circuit 32 as
depicted in FIG. 10, a lockout function as described
above can be provided. An example of a circuit
15 containing such a lockout function is described in co-
pending, commonly-assigned United States patent
application Serial No. 07/444,818, filed on December 1,
1989, and hereby incorporated by reference in its
entirety.

20 Thus it is seen that a flavor generating
article which combusts a flavor generating medium by
electrical heating to produce a consistent release of
flavor-containing substance with each puff, which
reaches combustion temperature quickly, which is self-
25 contained, and which can have the appearance of a
conventional cigarette, is provided. One skilled in
the art will appreciate that the present invention can
be practiced by other than the described embodiments,
which are presented for purposes of illustration and
30 not of limitation, and the present invention is limited
only by the claims which follow.

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CLAIMS:

1. An article for delivering to a consumer an inhalable flavor-containing substance, said article comprising a flavor generating medium, electrical heating means, a source of electrical energy for powering the electrical heating means, and control means, wherein the flavor-generating medium comprises a plurality of pre-measured charges of flavor-generating medium, the heating means individually heats each of said plurality of charges, and the control means applies the electrical energy to the electrical heating means to heat, at any one time, at least one but less than all of said plurality of charges to combustion, each charge, when combusted, delivering a quantity of flavor-containing substance to the consumer.
2. The article of claim 1, wherein said flavor generating medium comprises tobacco; and a flavor-containing substance comprises tobacco components and products of combustion are formed on combusting the flavor-generating medium.
3. The article of claim 1 or 2, wherein the flavor-generating medium comprises an aerosol-forming material; which forms an aerosol on combustion.
4. The article of claim 3, wherein said aerosol-forming material comprises glycerine.
5. The article of claim 3 or 4, wherein said aerosol-forming material comprises water.
6. The article of any of claims 3 to 5 appendent claim 2, wherein the flavor-generating medium is a dried slurry comprising ground tobacco and said aerosol-forming material.
7. The article of any preceding claim, wherein said flavor-generating medium comprises tobacco extracts.

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8. The article of any preceding claim, wherein said flavor-generating medium comprises condensed components of smoke produced by combustion of tobacco.

9. The article of any preceding claim, wherein said electrical heating means comprises resistance heating means in contact with said flavor-generating medium.

10. The article of claim 9, wherein the resistance heating means is a mesh of resistive wire; and the flavor-generating medium is deposited on said wire mesh.

11. The article of any preceding claim, wherein the plurality of charges of flavor-generating medium are deposited on a substrate; and the electrical heating means is in contact with said substrate.

12. The article of claim 10 or 11, comprising an adhesion agent for adhering the flavor-generating medium to the mesh, or substrate.

13. The article of claim 12, wherein the adhesion agent is a pectin.

14. The article of claim 13, wherein the pectin is a citrus pectin.

15. The article of any preceding claim, wherein said flavor-generating medium is concentrated, thereby reducing the amount of electrical energy necessary to cause combustion of said flavor-containing substance.

16. The article of claim 11, wherein said electrical heating means comprises a plurality of heating elements corresponding to a plurality of charges.

17. The article of claim 11 wherein said electrical heating means comprises a heating element, and means for

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indexing said substrate past the heating element.

18. The article of any of claims 1 to 8, wherein the plurality of charges of flavor generating medium are deposited on a substrate, and the electrical heating means is spaced apart from said substrate.

19. The article of any of claims 1 to 8, wherein the said flavor of generating medium comprises an electrically conductive material having a selected resistance; whereby said electrical heating means is integral with said flavor-generating medium.

20. The article of claim 19, wherein the electrical heating means comprises means for conducting electrical energy from the source of electrical energy to the electrically conductive flavor-generating medium.

21. The article of claim 20, wherein the electrical heating means comprises a plurality of conducting means corresponding to the plurality of charges, each conducting means contacting one charge.

22. The article of claim 19, 20 or 21, wherein the plurality of charges of flavor-generating medium are deposited on a substrate, and the electrical heating means comprises a plurality of conducting means corresponding to said plurality of charges, each of said conducting means contacting one of said charges.

23. The article of any of claims 19 to 22, wherein the plurality of charges of flavor-generating medium are deposited on a substrate, and the electrical heating means comprises; a conducting means for contacting the charges, and means for indexing the substrate past said conducting means, whereby the said conducting means sequentially contacts each charge.

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24. The article of any preceding claim wherein said electrical heating means comprises graphite.

25. The article of claim 24, wherein said graphite is compounded with other forms of carbon.

26. The article of claim 24 or 25, wherein the said electrical heating means further comprises electrical contact means for contacting the graphite, and the said graphite is coated with a contact resistance reducing substance.

27. The article of claim 26, wherein the contact-resistance reducing substance comprises tantalum.

28. The article of any of claims 24 to 27, wherein the heating means comprises a cylindrical structure comprising graphite and having a plurality of radial extending vanes, at least one surface of each vane being coated with the flavor generating medium such that each vane has one of the plurality of charges thereon, one of the axial and radial edges of the vanes all being connected in common to the electrical energy source and the other of the axial and radial edges being connected individually to the electrical energy source.

29. The article of claim 28, wherein the heating means comprises a cylinder comprising graphite, and having a continuous cylindrical outer surface, wherein the vanes extend inwardly therefrom to a respective inner edge at a point short of the axis of the cylinder, the outer surface comprising the common connection to the electrical energy source, and each said inner edge comprising the individual connection to the electrical energy source.

30. The article of claim 28, wherein the heating means comprises a graphite cylinder having a cylindrical inner core, wherein the vanes extend outwardly therefrom to a

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respective outer edge at a point remote from the axis of said cylinder, the inner core comprising the common connection to the electrical energy source, and each said outer edge comprising the individual connection to the electrical energy source.

31. The article of any of claims 24 to 27, wherein the heating means comprises a hollow graphite cylinder having the flavor generating medium coated thereon, the cylinder being divided by at least one pair of opposed partially circumferential slits into a plurality of opposed circumferential strips, each strip of an opposed pair of strips being connected to a pole of said source of electrical energy to form a ring-like heating segment; the flavor generating medium on said inner side of each of the ring-like segments forming one of the plurality of charges.

32. The article of any of claims 24 to 27, wherein the heating means comprises a graphite cylinder having an outer surface with a plurality of grooves therein separated by the lands thereon, each groove being coated with the flavor generating medium and forming one of said individual charges thereof, each groove being heated by applying power from said source of electrical energy to a land on either side of said groove.

33. The article of any of claims 24 to 27 wherein, the heating means comprises a ring comprising graphite and being divided by first and second interleaved sets of slits, extending from a respective end more than half-way to the opposite end, into a plurality of bases adjacent a first end and into fingers adjacent said second end, the fingers being coated with said flavor generating medium, wherein individual charges of flavor generating medium are heated to combustion either by applying power from the electrical energy source to one of the bases and one of the fingers, or to adjacent bases.

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34. The article of claim 33, wherein the flavor generating medium is coated onto the ring in a circumferential band in an area overlapped by both the first and second sets of slits, individual charges of flavor generating medium being heated by applying power from the electrical energy source to adjacent bases.

35. The article of claim 33, wherein the flavor generating medium is coated onto the ring in a circumferential band in an area beginning at the second and extending towards the first end for a distance shorter than that over which the set of slits extending from said second end extends, individual charges of flavor generating medium being heated by applying power from the source of electrical energy to base and a finger.

36. The article of any of claims 24 to 27, wherein the heating means comprises an elongated sheet comprising graphite, and divided laterally into opposed pairs of strips, the slits extending inwardly from the longitudinal edges of said sheet, the flavor-generating medium being coated onto the sheet in a longitudinal band spaced from the longitudinal edges, and individual charges of said flavor-generating medium being heated to combustion by applying power from the electrical energy source to opposed strips.

37. The article of any of claims 24 to 29, wherein the heating means comprises a plurality of U-shaped vanes, each vane having two legs of unequal length interconnected at their proximate ends by a base, each vane being joined to an electrically conductive hub at the distal end of their longer leg to orientate the vanes radially with the longer legs adjacent one another, the bases extending radially outward, and the shorter legs extending parallel to the longer legs but spaced radially outwardly therefrom, wherein the vanes are coated with said flavor-generating medium, individual charges of flavor-generating medium

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being heated to combustion by applying power from electrical energy source to the hub and to a respective shorter leg.

38. The article of any preceding claim, wherein the source of electrical energy comprises a battery.

39. The article of claim 38, wherein the battery is disposable.

40. The article of claim 38, wherein the battery is rechargeable.

41. The article of any preceding claim wherein the source of electrical energy comprises a capacitor.

42. The article of claim 41, wherein the source of electrical energy further comprises means for charging the capacitor.

43. The article of claim 42 and any of claims 38 to 40, wherein the battery comprises the capacitor charging means.

44. The article of claim 42 or 43, wherein the capacitor charging means comprises contact means for connecting the capacitor to an external voltage source.

45. The article of claim 44, wherein the capacitor has a capacitance sufficient to store energy for heating to combustion at least one of said charges of flavor-generating medium.

46. The article of claim 45, wherein the capacitance is sufficient to store energy for heating to combustion all of said plurality of charges of flavor-generating medium.

47. The article of any preceding claim, wherein the control means comprises means for selecting at least one

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but less than all of said plurality of charges of flavor-generating medium; and means for applying a pulse of electrical energy to the heating means to combust the selected flavor-generating medium when a consumer puffs at the article.

48. The article of claim 47, wherein the selected means is manual.

49. The article of claim 47, wherein the selecting means is automatic.

50. The article of claim 49, wherein the automatic selecting means selects each of said plurality of charges sequentially.

51. The article of claim 49 or 50, wherein the control means further comprises sequential indication means for indicating which charge is selected.

52. The article of any of claims 47 to 51, wherein the pulse applying means applies a pulse of predetermined duration.

53. The article of claim 52, wherein the control means further comprises pulse indication means for indicating when said pulse is being applied.

54. The article of claim 50 or 51, wherein the pulse applying means comprises actuation of said actuation means by a consumer.

55. The article of claim 54, wherein the control means further comprises lockout means for disabling the actuation means for a predetermined lockout period after an actuation thereof.

56. The article of claim 54 or 55, wherein the actuation

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means comprises a pushbutton.

57. The article of claim 54, 55 or 56, wherein the actuation means comprises a switch actuated when a consumer draws on the article.

58. The article of claim 57, wherein the switch is actuated by a pressure-sensitive sensor.

59. The article of claim 57, wherein the switch is actuated by a flow-sensitive sensor.

60. The article of any preceding claim, wherein the control means causes the heating means to heat to combustion a charge of flavor-generating medium within about four seconds.

61. The article of claim 60, wherein the control means causes the heating means to heat to combustion a charge of flavor-generating medium within about one second.

62. The article of claim 61, wherein the control means causes the heating means to heat to combustion a charge of flavor-generating medium within about 0.5 seconds.

63. The article of any preceding claim, wherein the electrical heating means includes a hot spot.

64. The article of any preceding claim further comprising an oxidizing agent.

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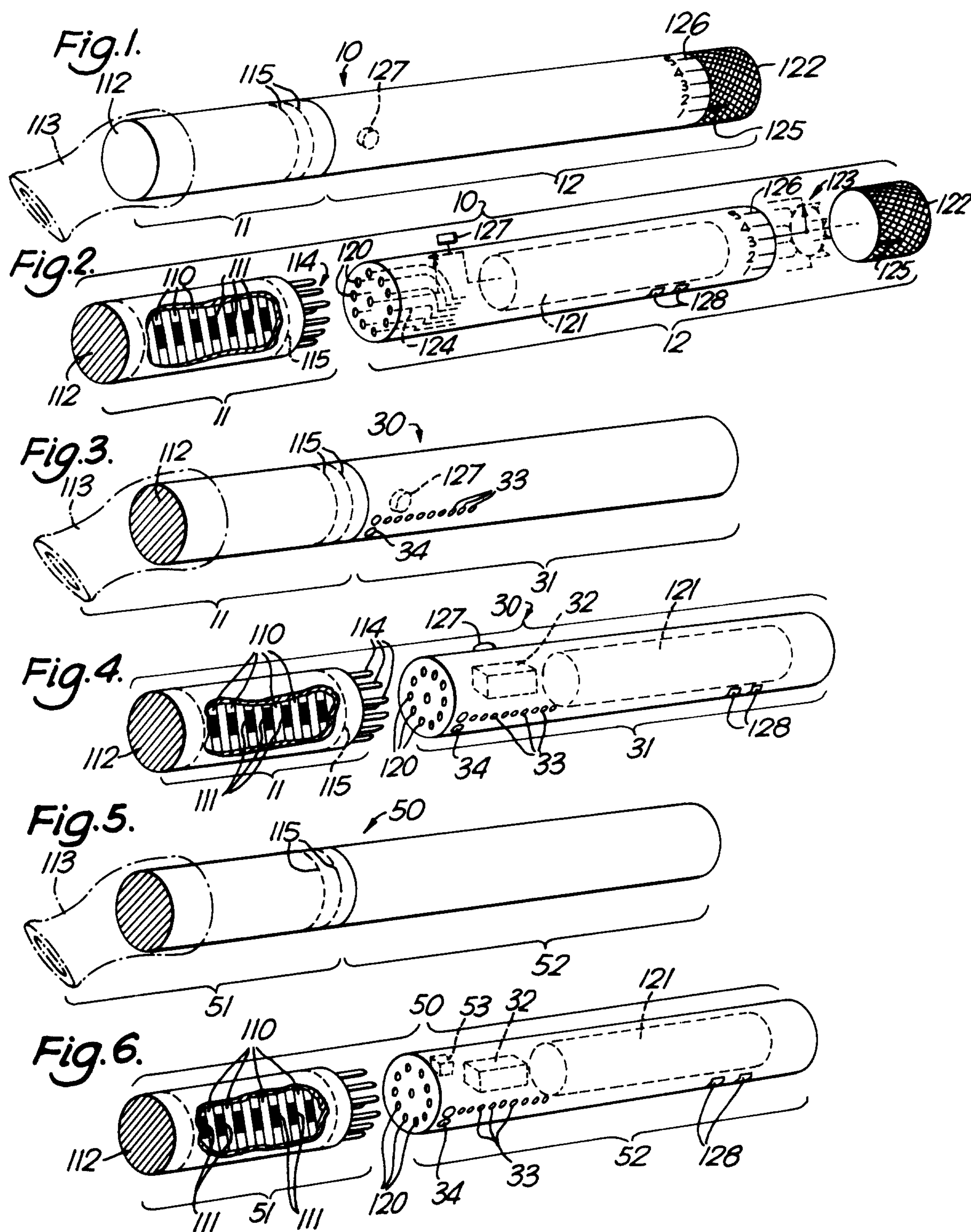


Fig. 7A.

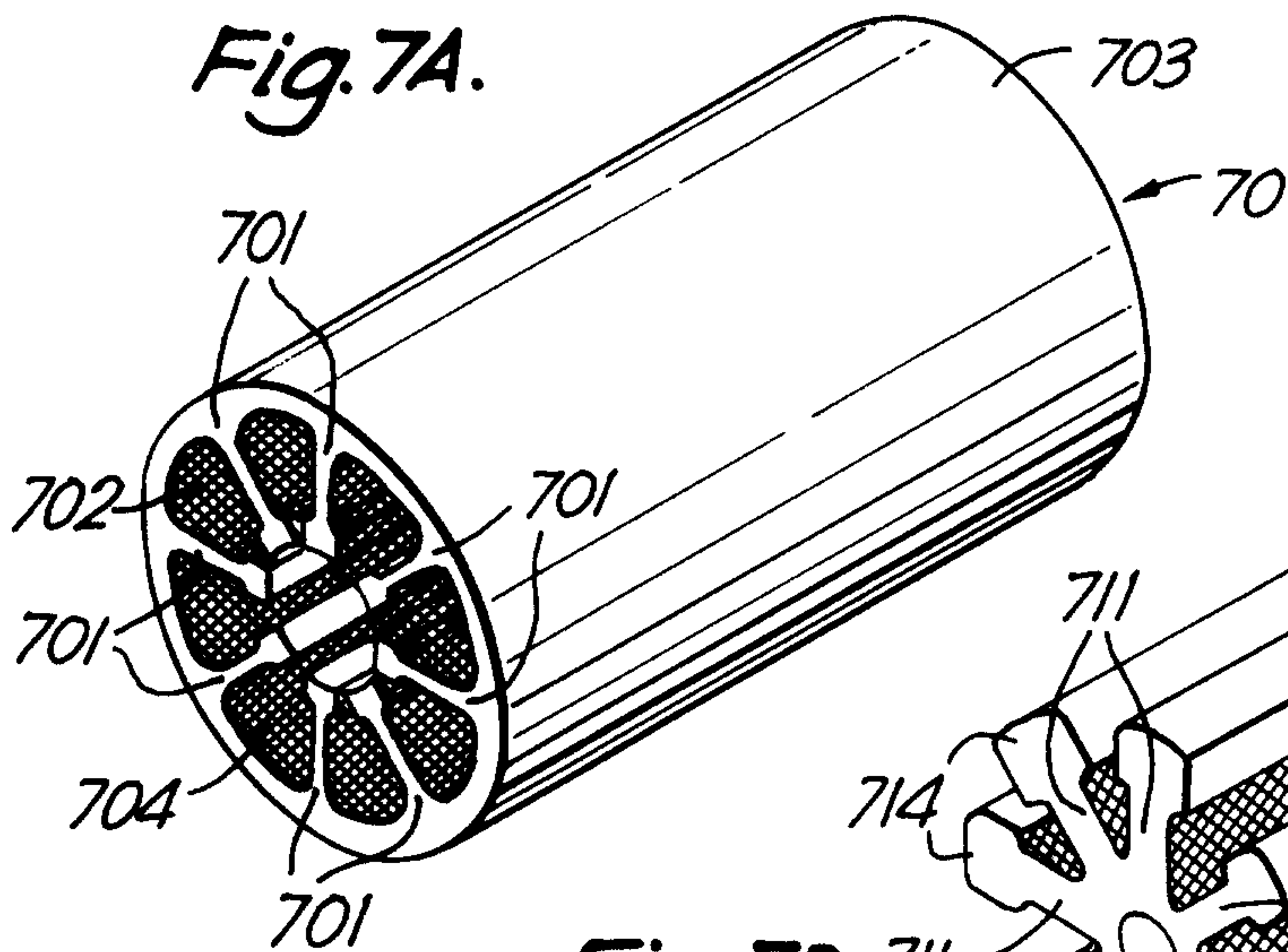


Fig. 7B.

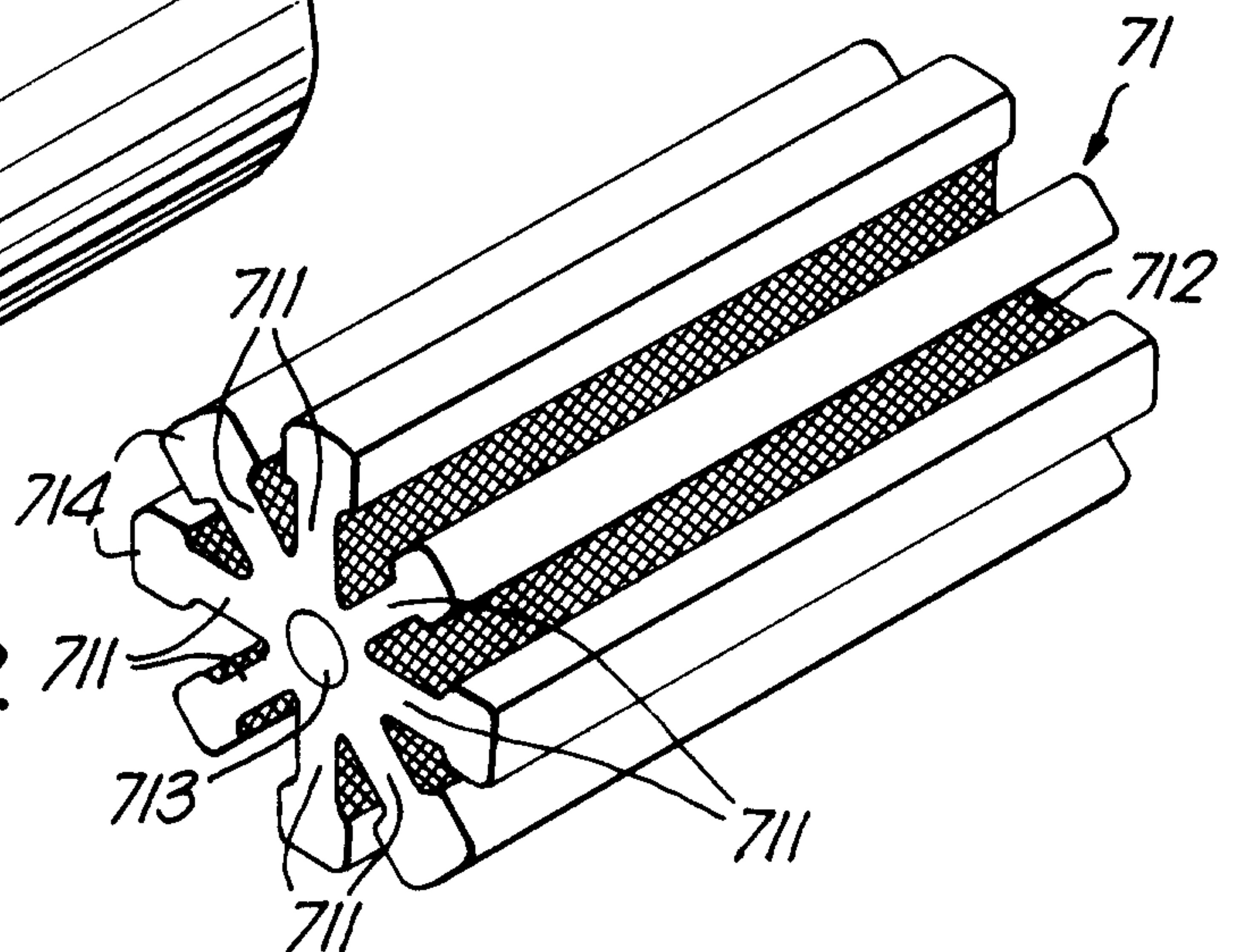


Fig. 7C.

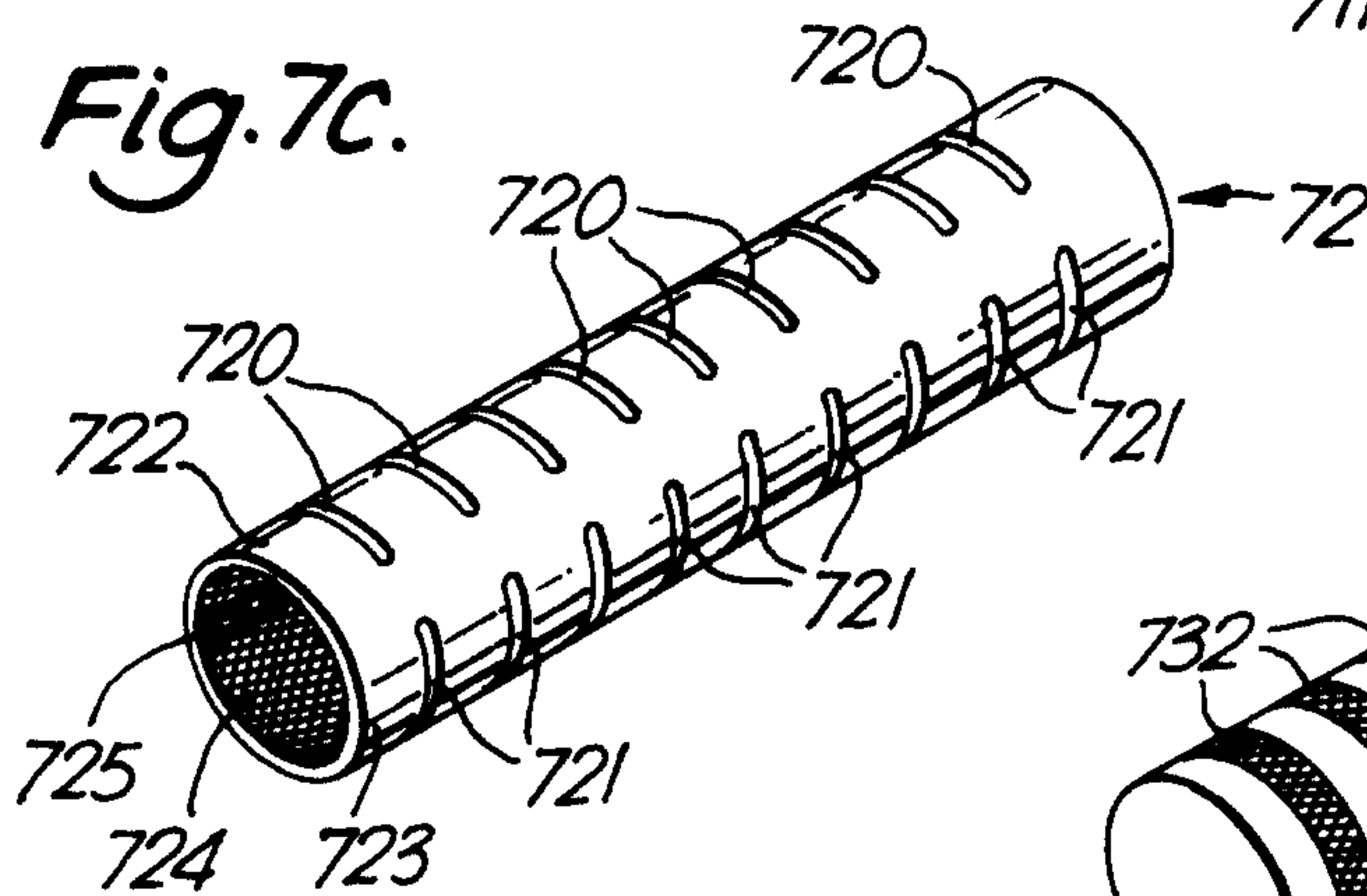


Fig. 7D.

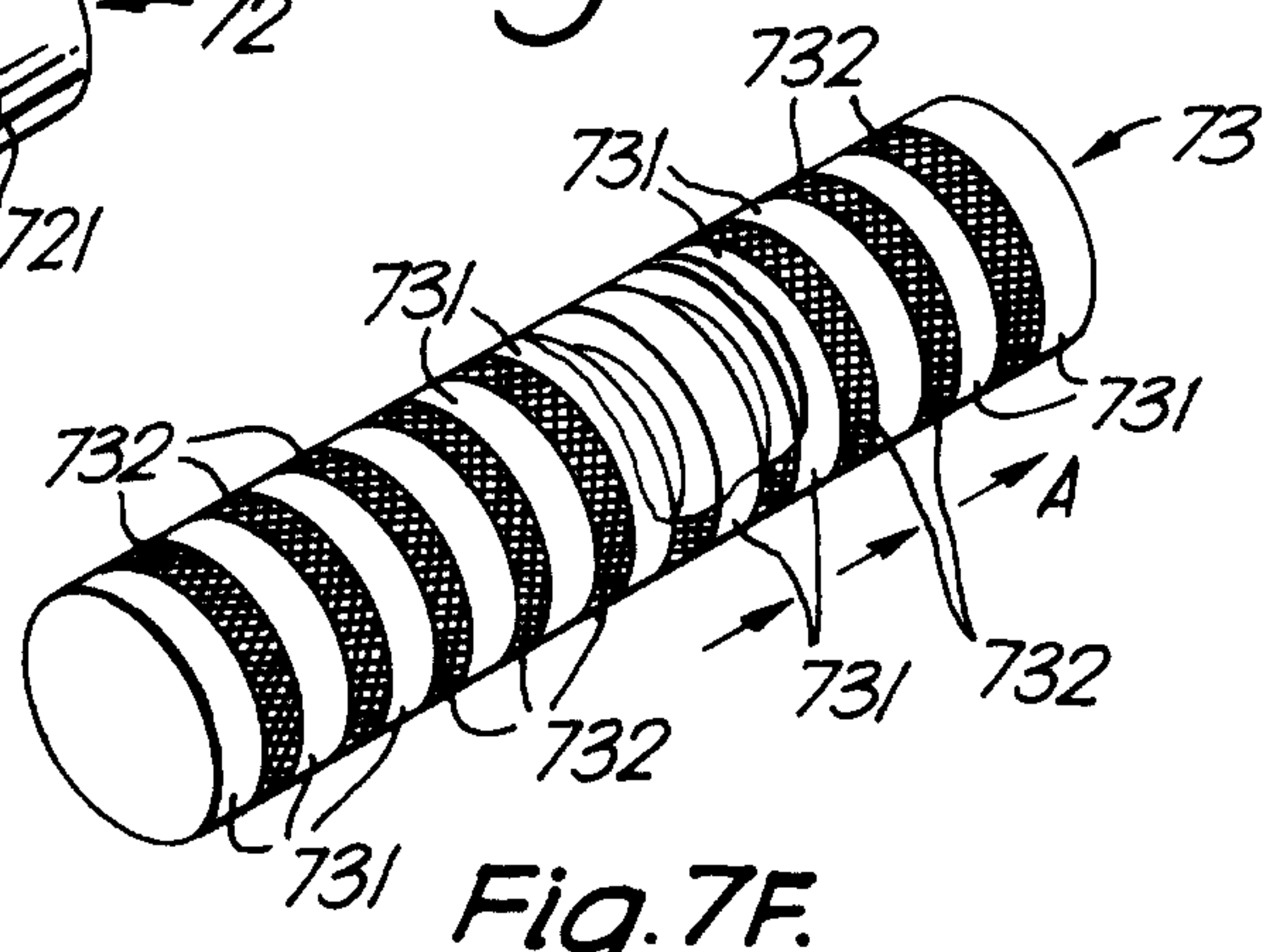


Fig. 7E.

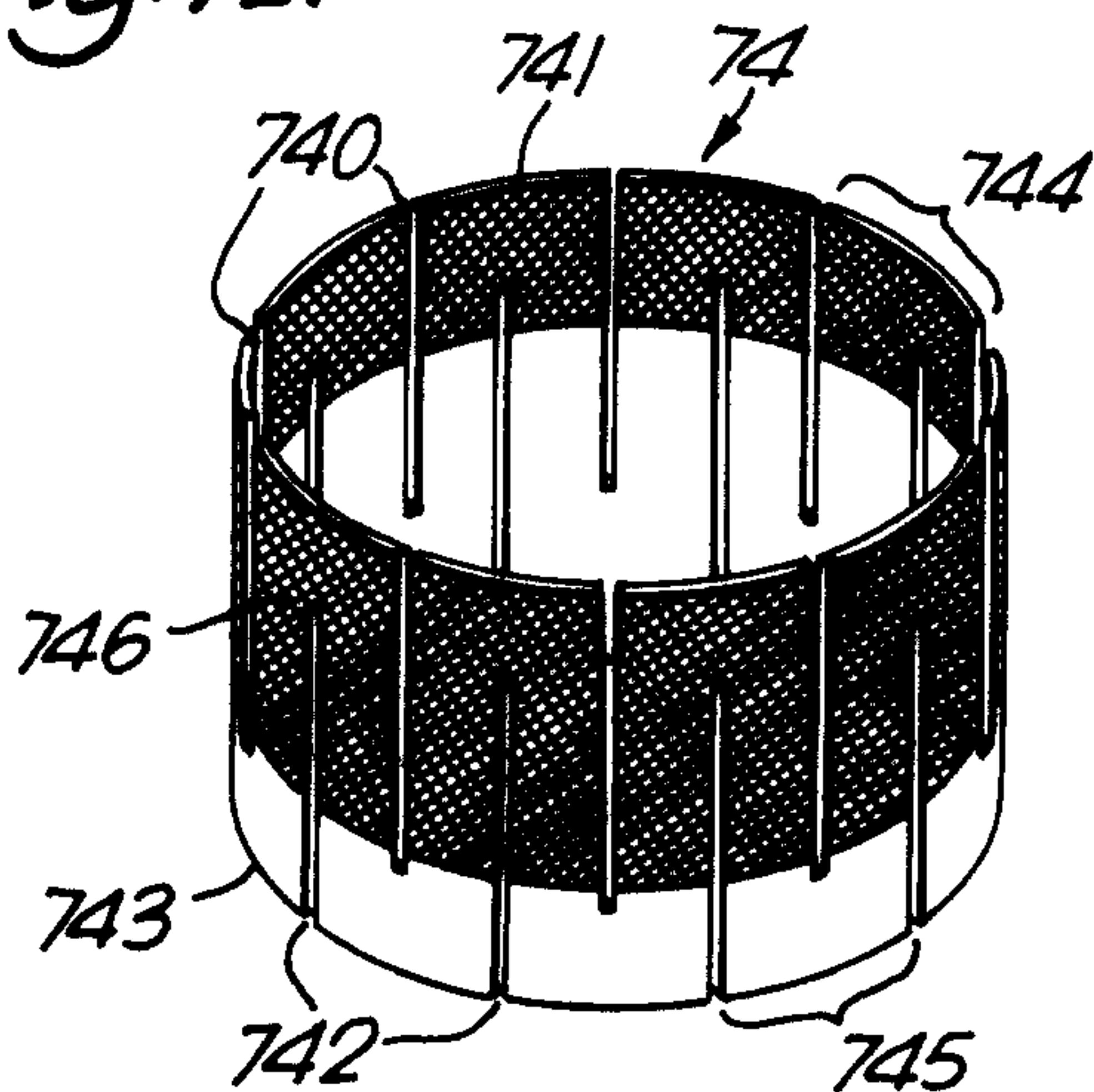
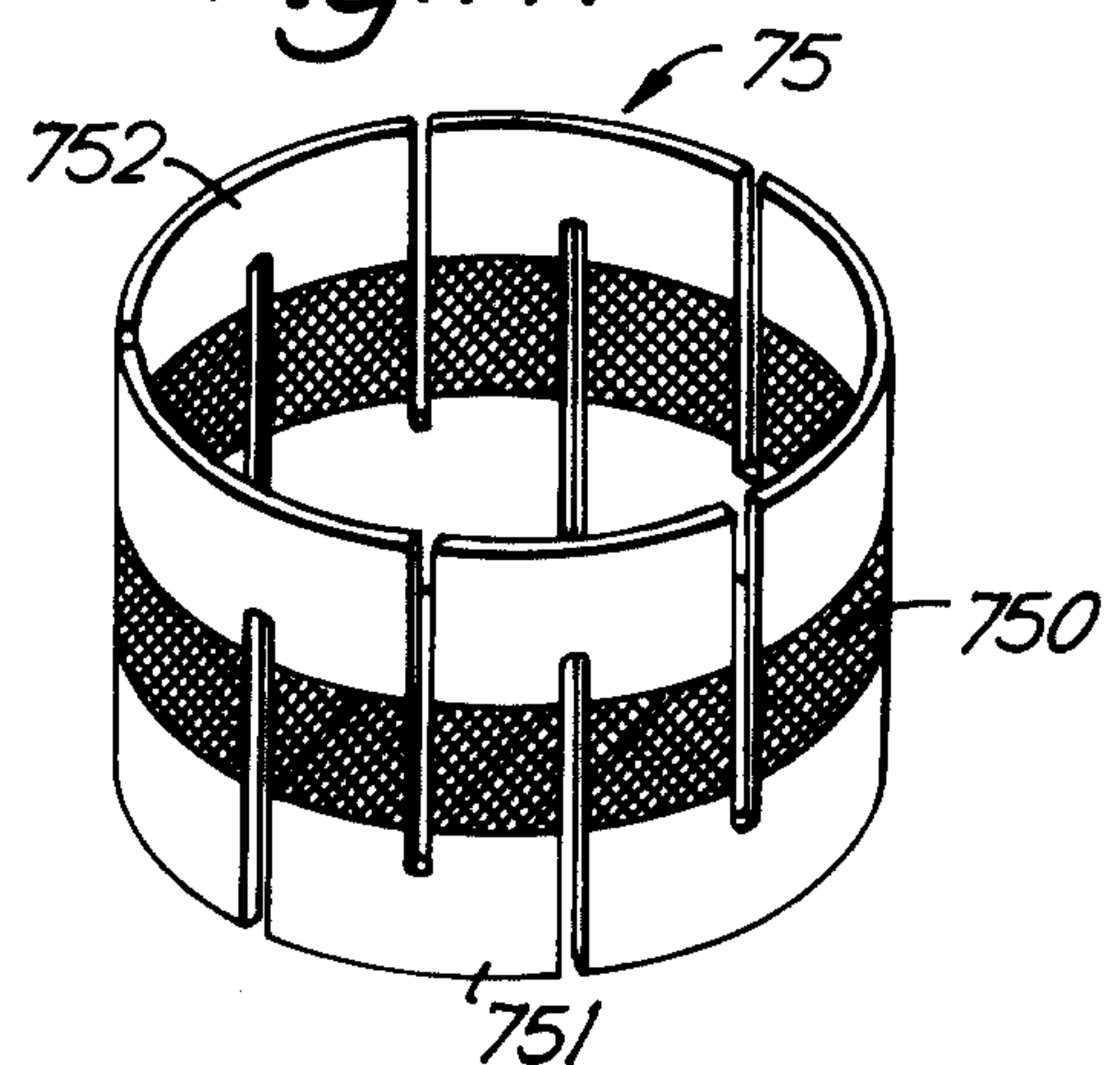


Fig. 7F.



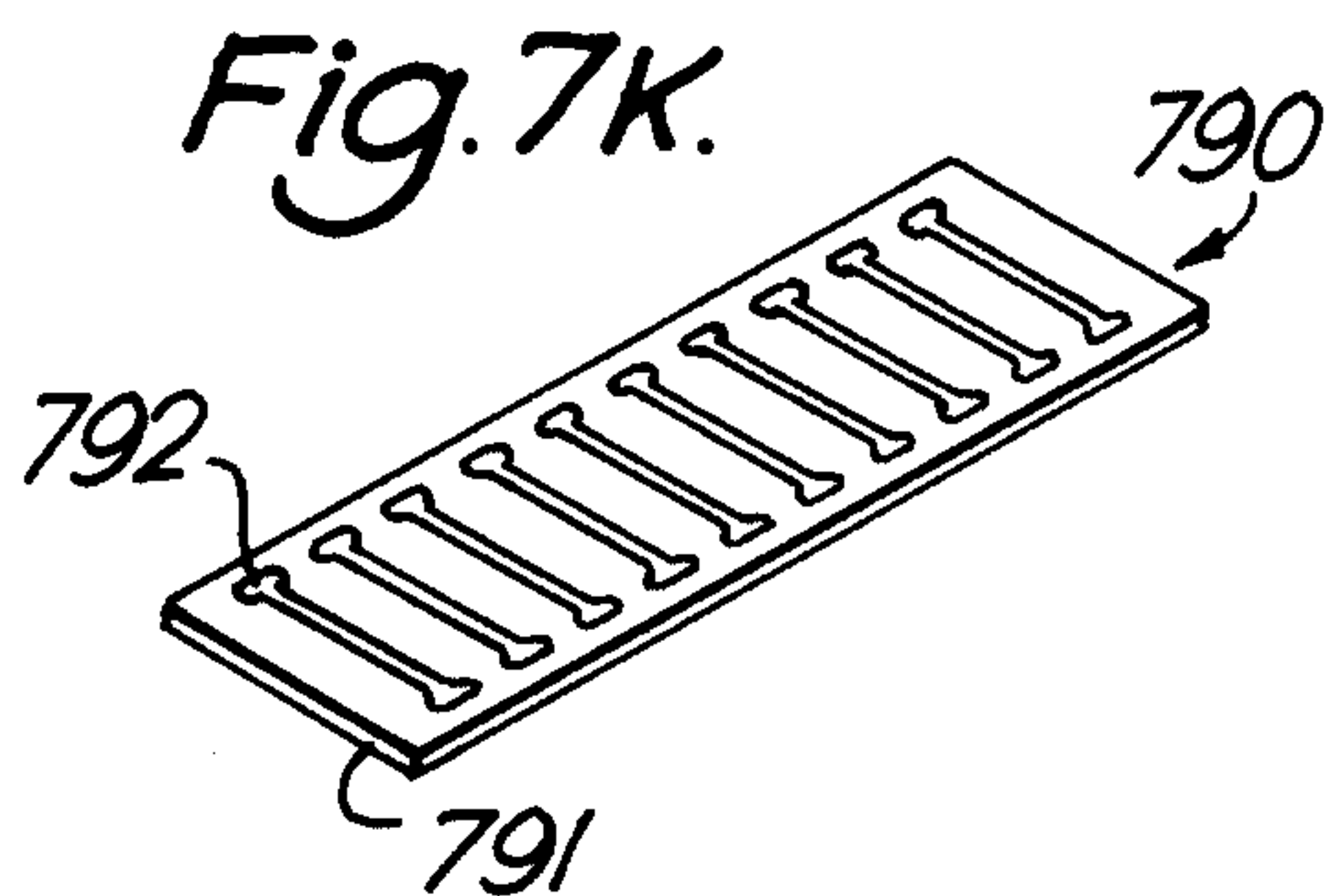
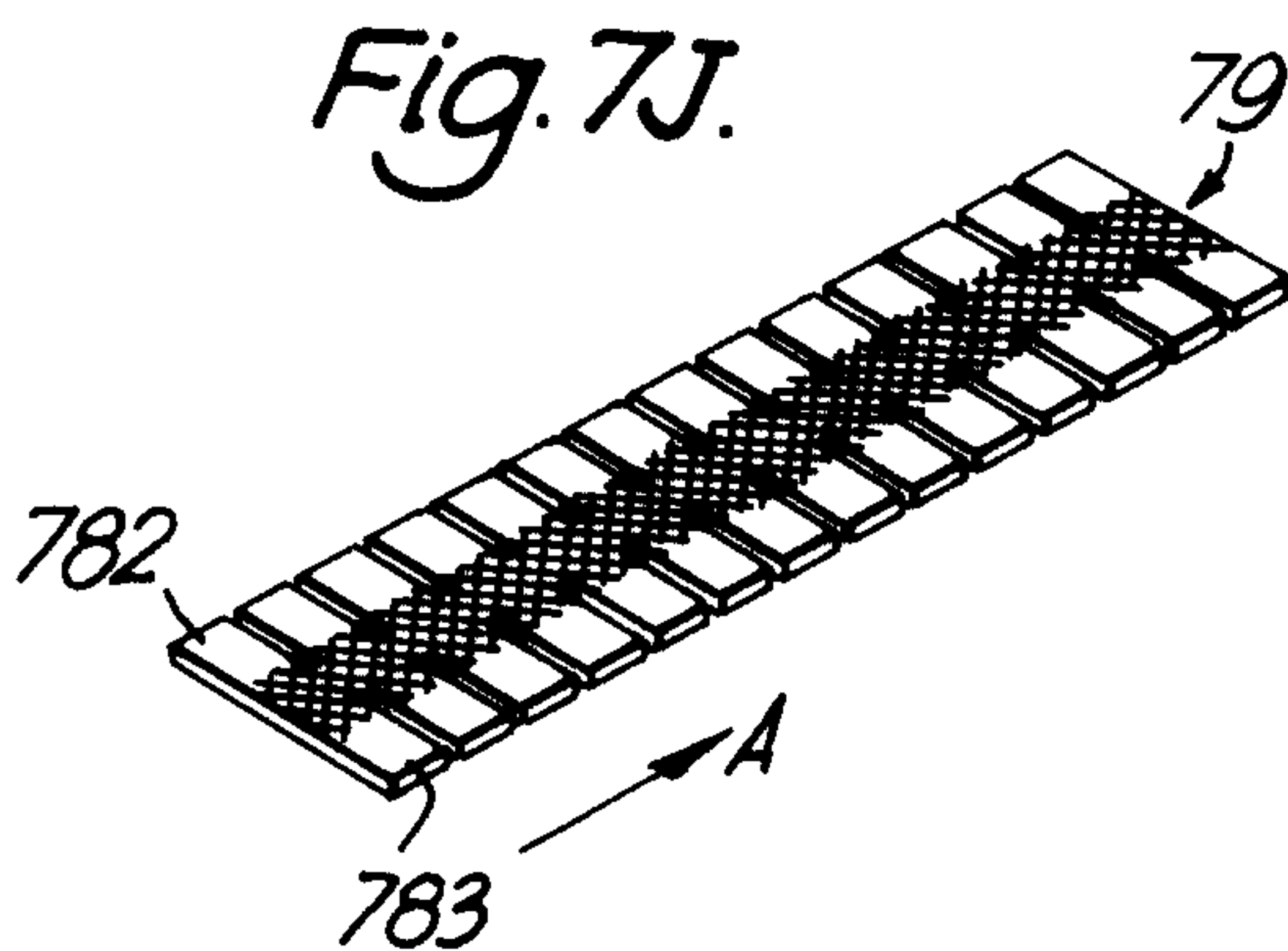
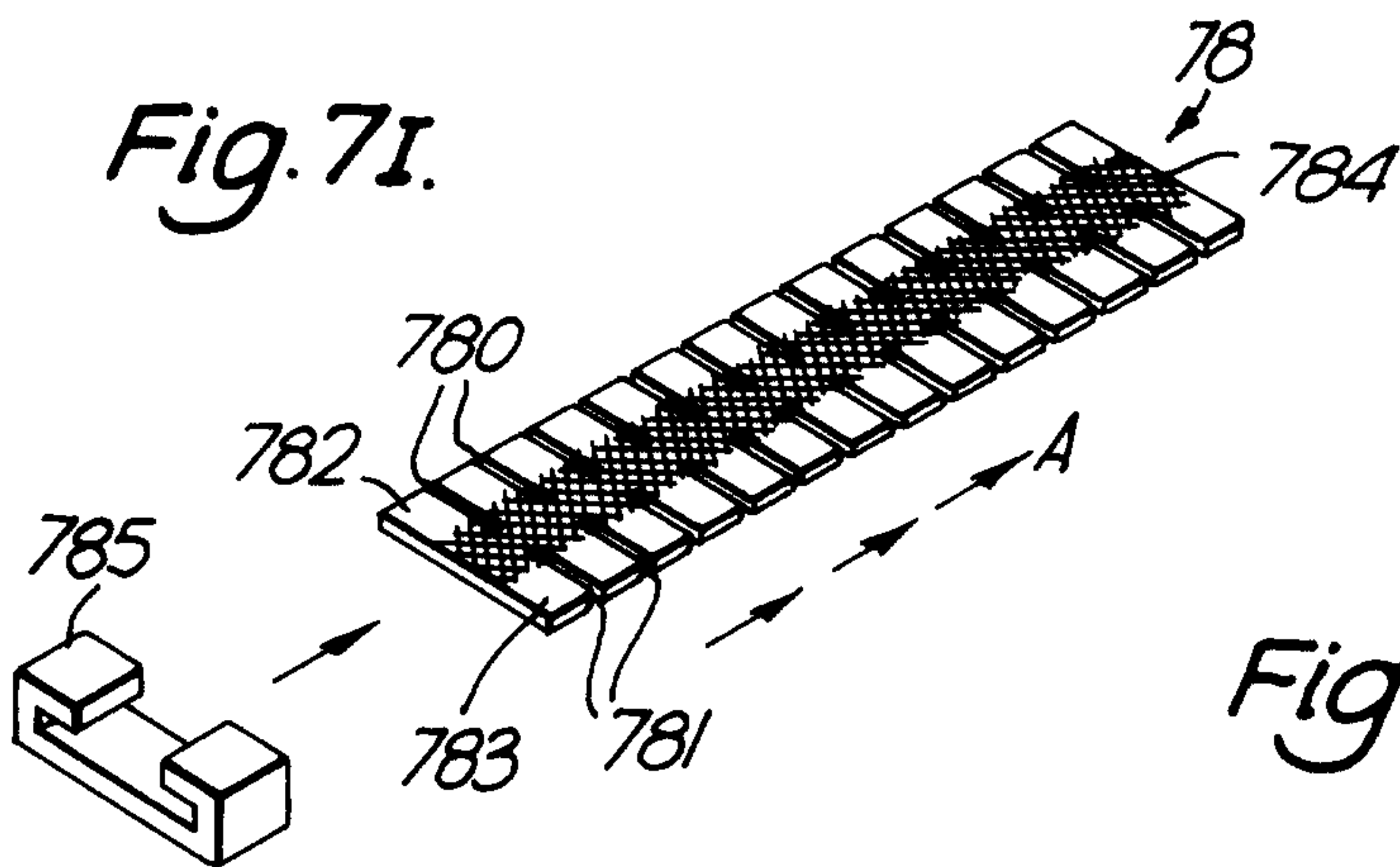
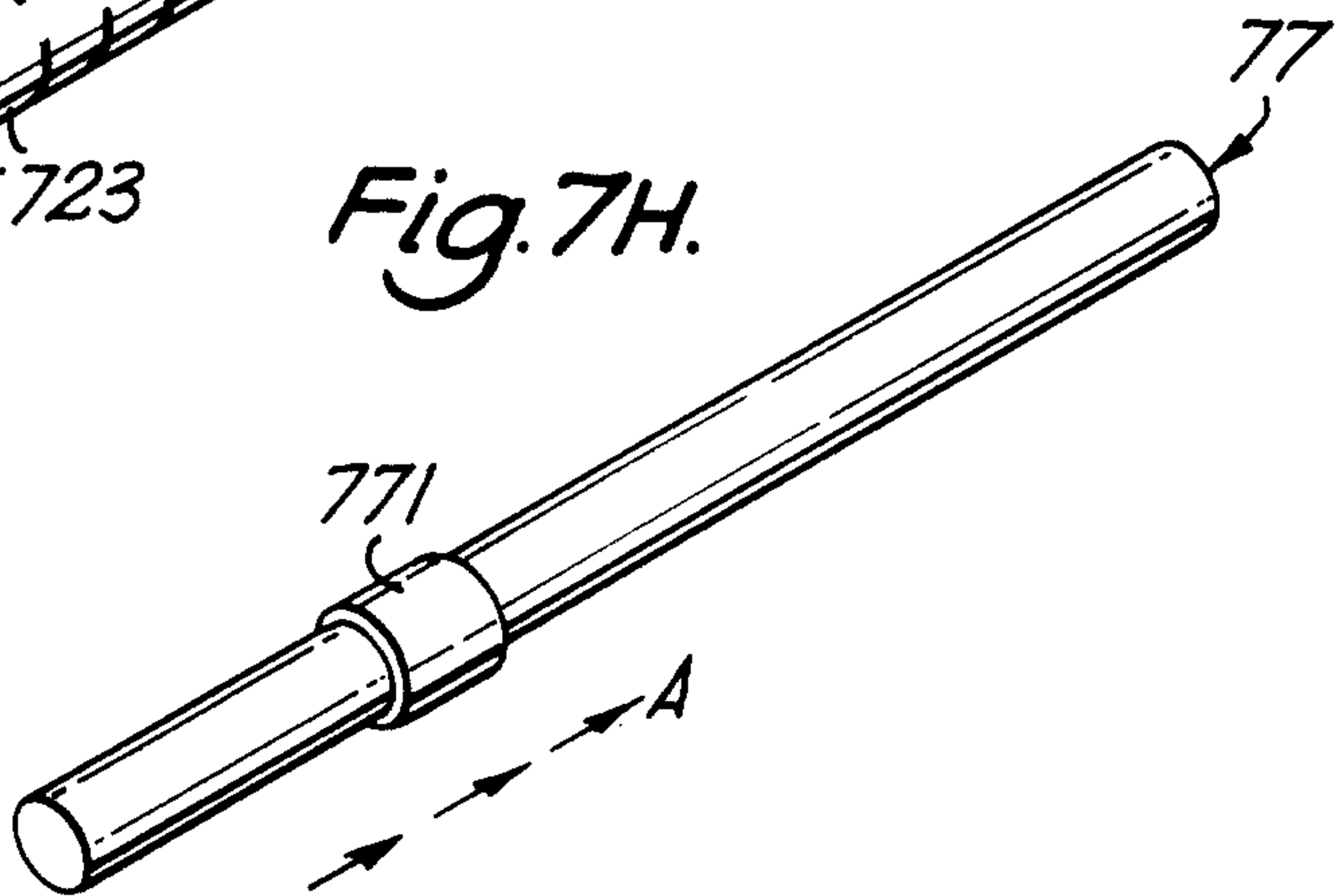
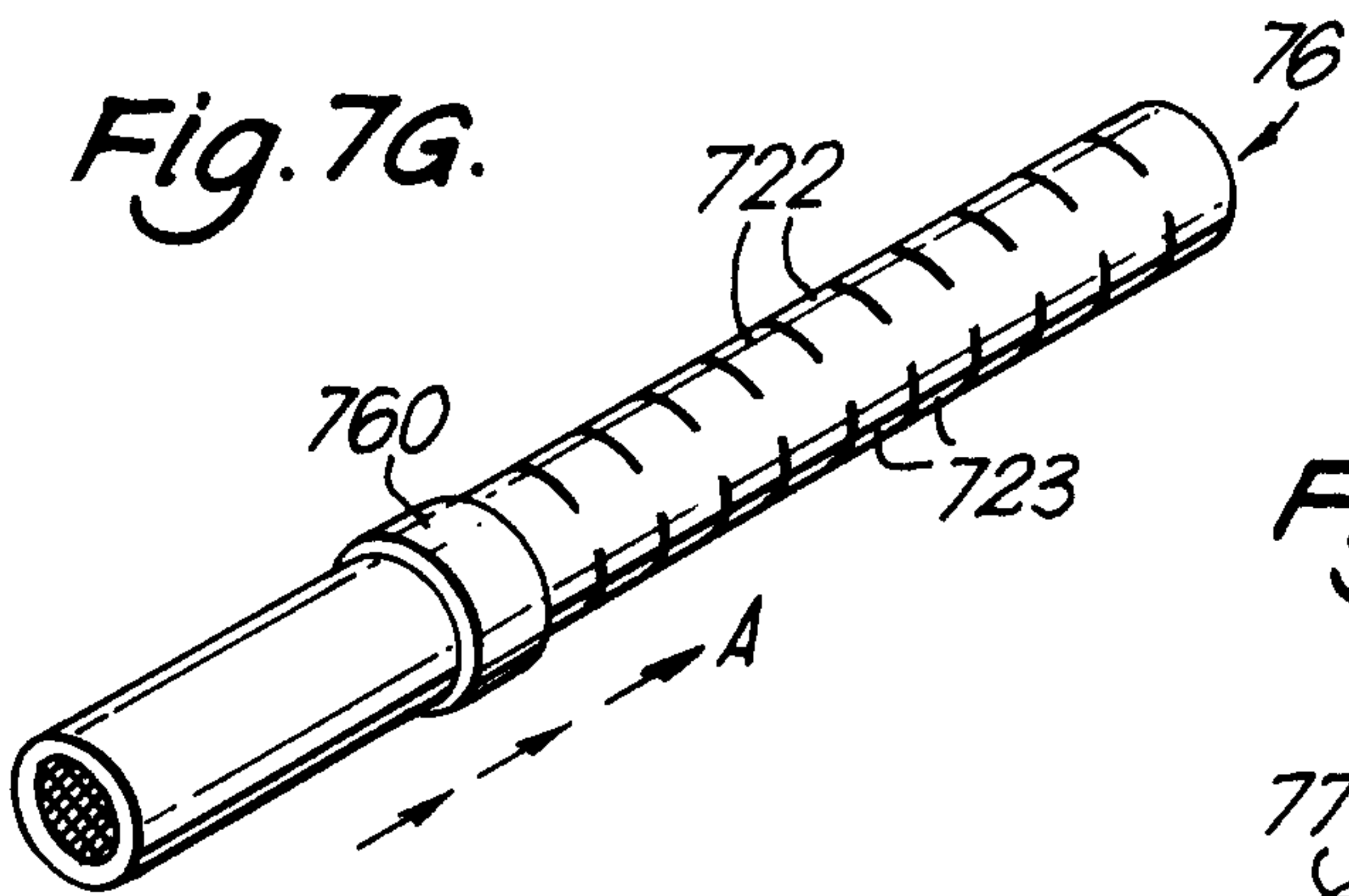


Fig. 8A.

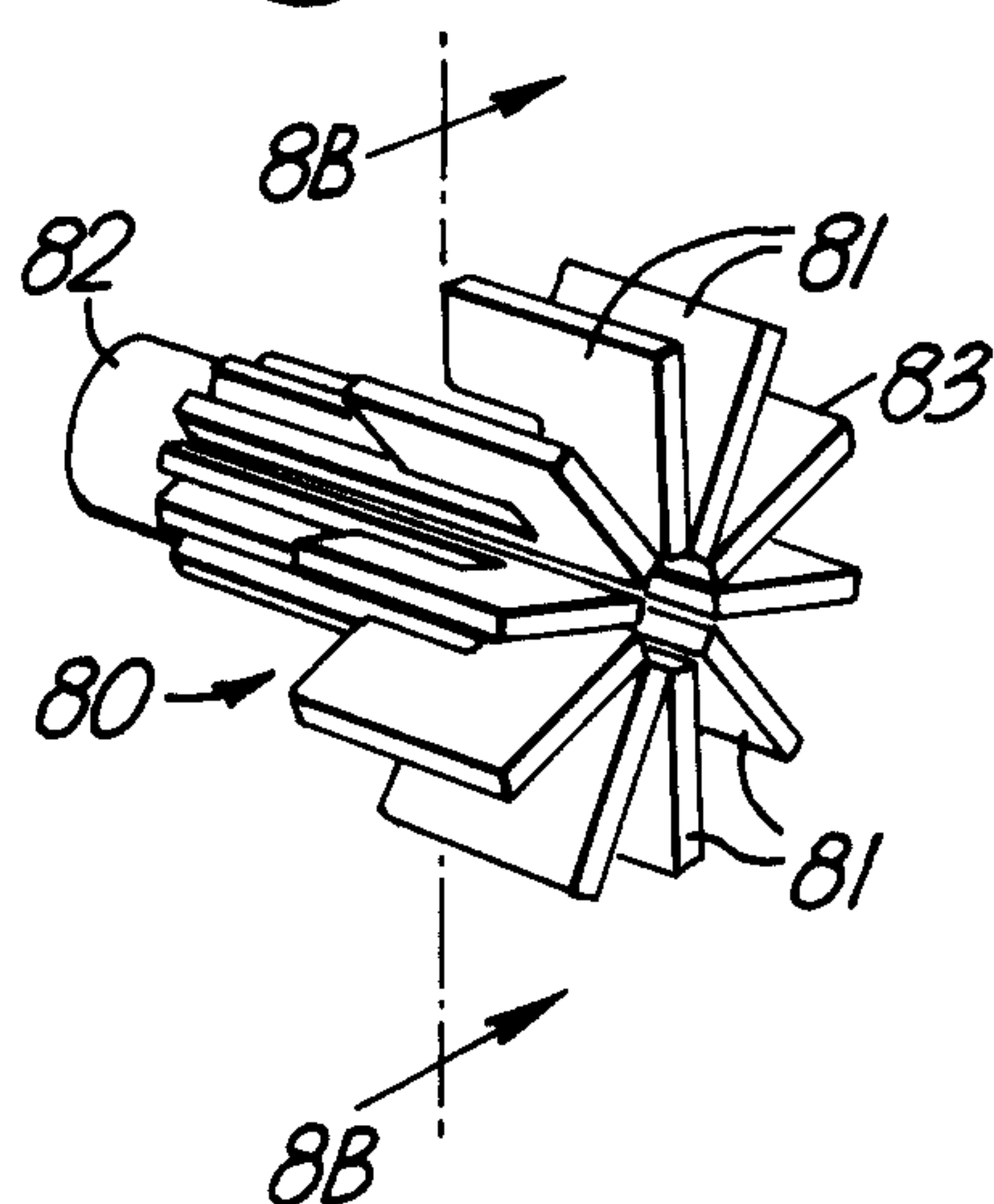


Fig. 8B.

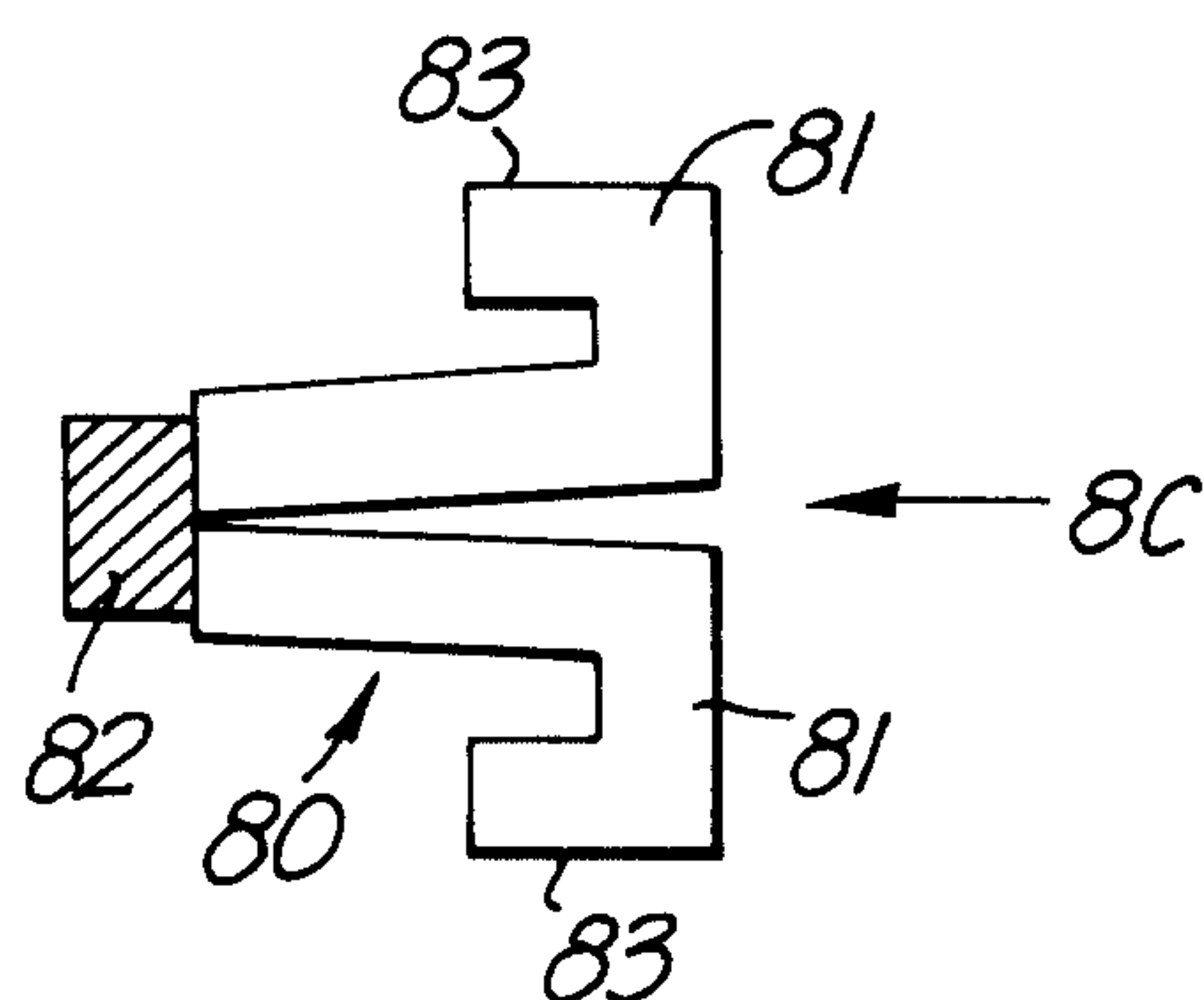


Fig. 8C.

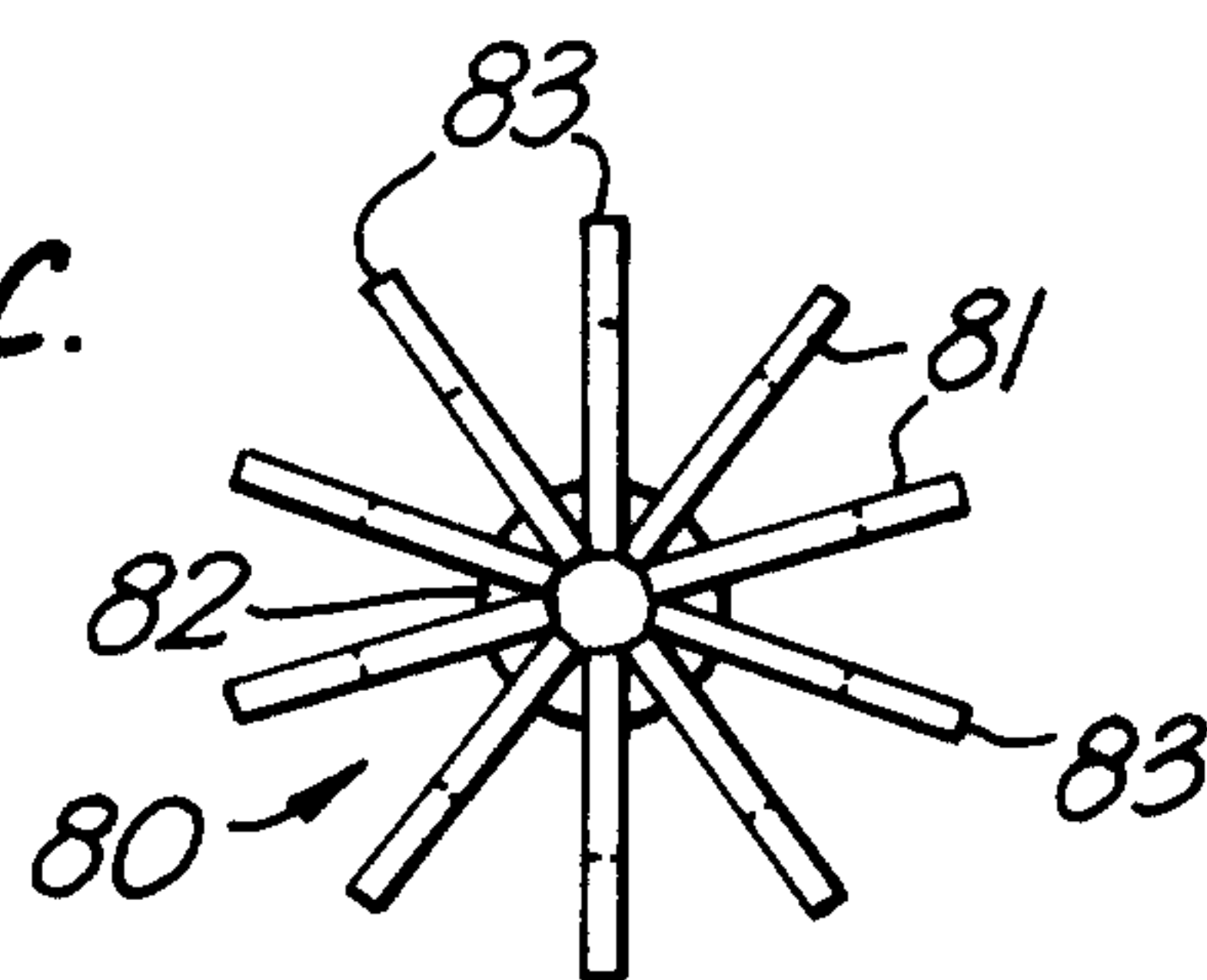


Fig. 9.

